MINIMUM STANDARD 3.14

VEGETATED FILTER STRIP

View BMP Images

LIST OF ILLUSTRATIONS

MINIMUM STANDARD 3.14

VEGETATED FILTER STRIP

Definition

A vegetated filter strip is a densely vegetated strip of land engineered to accept runoff from upstream development as *overland sheet flow*. It may adopt any naturally vegetated form, from grassy meadow to small forest.

Purpose

The purpose of a vegetated filter strip is to enhance the quality of stormwater runoff through filtration, sediment deposition, infiltration and absorption.

A vegetated filter strip may be used as a pretreatment BMP in conjunction with a primary BMP. This reduces the sediment and particulate pollutant load that could reaching the primary BMP, which, in turn, reduces the BMP's maintenance costs and enhances its pollutant removal capabilities.

TABLE 3.14 - 1
Pollutant Removal Efficiency for Vegetated Filter Strips

BMP	Target Phosphorus Removal Efficiency	Impervious Cover
Vegetated Filter Strip	10%	16 - 21%

Vegetated filter strips rely on their flat cross-slope and dense vegetation to enhance water quality. Their flat cross-slope assures that runoff remains as sheet flow while filtering through the vegetation. There is limited ponding or storage associated with these BMPs, so they are ineffective for reducing peak discharges. Vegetated filter strips may lower runoff velocities and, sometimes, runoff volume. Typically, however, the volume reduction is not adequate for controlling stream channel erosion or flooding.

Conditions Where Practice Applies

Drainage Area

A vegetated filter strip should not receive large volumes of runoff since such flows tend to concentrate and form channels. Channels within a filter strip allow runoff to short-circuit the BMP, rendering it ineffective. Therefore, the contributing drainage area for a vegetated filter strip is based on the linear distance behind it that is maintained as sheet flow. Runoff is assumed to change from sheet flow to shallow concentrated flow after traveling 150 feet over **pervious** surfaces and 75 feet over **impervious** surfaces (Center for Watershed Protection, 1996). A level spreader may be used to convert shallow concentrated flow from larger areas back to sheet flow before it enters the filter strip. In any event, the contributing drainage area should never exceed five acres.

Development Conditions

Vegetated filter strips have historically been used and proven successful on agricultural lands, primarily due to their low runoff volumes. In urban settings, filter strips are most effective in treating runoff from isolated impervious areas such as rooftops, small parking areas, and other small impervious areas. Filter strips should not be used to control large impervious areas.

Since vegetated filter strips should not be used to treat concentrated flows, they are suitable only for low- to medium-density development (16-21% impervious), or as a pretreatment component for structural BMPs in higher density developments.

Planning Considerations

Site Conditions

The following site conditions should be considered when selecting a vegetated filter strip as a water quality BMP:

1. **Soils –** Vegetated filter strips should be used with soils having an infiltration rate of 0.52 inches/hour; (sandy loam, loamy sand). Soils should be capable of sustaining adequate stands of vegetation with minimal fertilization.

2. **Topography –** Topography should be relatively flat to maintain sheet flow conditions. Filter strips function best on 5 percent or less (NVPDC).

3. **Depth of Water Table –** A shallow or seasonally high groundwater table will inhibit the opportunity for infiltration. Therefore, the lowest elevation in the filter strip should be at least 2 feet above the water table.

If the soil's permeability and/or depth to water table are unsuitable for infiltration, the filter strip's primary function becomes the filtering and settling of pollutants. A modified design may be provided to allow ponding of the water quality volume at the filter's downstream end. The ponding area may be created by constructing a small permeable berm using a select soil mixture. (For berm details, see the Pervious Berm section in this standard.) The maximum ponding depth behind the berm should be 1foot.

Water Quality Enhancement

Vegetated filter strips are occasionally installed as a standard feature in residential developments. To be used as a water quality BMP, however, filter strips must comply with certain design criteria. Vegetated filter strip designs should include specific construction, stabilization, and maintenance specifications. The most significant requirement is for runoff to be received as sheet flow. Certain enhancements may be necessary, such as added vegetation and grading specifications, or the use of level spreaders, to ensure that runoff enters the filter strip as sheet flow.

Sediment Control

A natural area that is designed to serve as a vegetated filter strip should not be used for temporary sediment control. Sediment deposition may have significant impacts on the existing vegetation. If a vegetated filter strip is proposed in a natural area marginally acceptable for use, due to topography or existing vegetation, then it may be appropriate to use the filter strip for temporary sediment control. However, when the project is completed, the sediment accumulation should be removed, the area should be regraded to create the proper design conditions (sheet flow), and the strip should be re-stabilized per the landscaping plan.

Design Criteria

This section provides recommendations and minimum design criteria for vegetated filter strips intended to enhance water quality. It is the designer's responsibility to decide which criteria are applicable to the each facility and to decide if any additional design elements are required. The designer must also provide for the long-term functioning of the BMP.

Hydrology

The hydrology of a filter strip's contributing drainage area should be developed per **Chapter 4, Hydrologic Methods**.

Filter Strip Geometry

Compliance with the following parameters will result in optimal filter strip performance (NVPDC):

1. **Length** – The minimum length of a filter strip should be 25 feet, at a maximum slope of 2 percent. The length should increase by 4 feet for any 1 percent increase in slope. **The optimum filter strip length is 80 to 100 feet**.

2. **Width** – The width of the filter strip (perpendicular to the slope) should be equal to the width of the contributing drainage area. When this is not practical, a level spreader should be used to reduce the flow width to that of the filter strip. The level spreader's width will determine the depth of flow and runoff velocity of the stormwater as it passes over the spreader lip and into the filter strip. A wide lip will distribute the flow over a longer level section, which reduces the potential for concentrated flow across the filter.

3. Slope – The slope of the filter strip should be as flat as possible while allowing for drainage. Saturation may occur when extremely flat slopes are used.

Level Spreader

A level spreader should be provided at the upper edge of a vegetated filter strip when the width of the contributing drainage area is greater than that of the filter (see Figure **3.14-2**.) Runoff may be directed to the level spreader as sheet flow or concentrated flow. However, the design must ensure that runoff fills the spreader evenly and flows over the level lip as uniformly as possible. The level spreader should extend across the width of the filter, leaving only 10 feet open on each end.

Pervious Berm

To force ponding in a vegetated filter strip, a pervious berm may be installed. It should be constructed using a moderately permeable soil such as ASTM *ML*, *SM*, or *SC*. Soils meeting USDA sandy loam or loamy sand texture, with a minimum of 10 to 25% clay, may also be used. Additional loam should be used on the berm (± 25%) to help support vegetation. An armored overflow should be provided to allow larger storms to pass without overtopping the berm. **Maximum ponding depth behind a pervious berm is 1 foot**.

Vegetation

A filter strip should be densely vegetated with a mix of erosion resistant plant species that effectively bind the soil. Certain plant types are more suitable than others for urban stormwater control. The selection of plants should be based on their compatibility with climate conditions, soils, and topography and the their ability to tolerate urban stresses from pollutants, variable soil moisture conditions and ponding fluctuations. Virginia has three major physiographic regions that reflect changes in soils and topography: Coastal Plain, Piedmont, and Appalachian and Blue Ridge regions (see **Figure 3.14- 3**).

A filter strip should have at least two of the following vegetation types:

- *deep-rooted grasses, ground covers, or vines*
- *deciduous and evergreen shrubs*
- *under- and over-story trees*

Native plant species should be used if possible. Non-native plants may require more care to adapt to local hydrology, climate, exposure, soil and other conditions. Also, some non-native plants may become invasive, ultimately choking out the native plant population. This is especially true for non-native plants used for stabilization.

Newly constructed stormwater BMPs will be fully exposed for several years before the buffer vegetation becomes adequately established. Therefore, plants which require full shade, are susceptible to winter kill or are prone to wind damage should be avoided.

Plant materials should conform to the American Standard for Nursery Stock, current issue, as published by the American Association of Nurserymen. The botanical (scientific) name of the plant species should be according to the landscape industry standard nomenclature. All plant material specified should be suited for USDA Plant Hardiness Zones 6 or 7 (see **Figure 3.14- 4**).

Construction Specifications

Overall, widely accepted construction standards and specifications, such as those developed by the USDA Soil Conservation Service or the U.S. Army Corps of Engineers, should be followed where applicable to construct a vegetated filter strip. The specifications should also satisfy all requirements of the local government.

Sequence of Construction

Vegetated filter strip construction should be coordinated with the overall project construction schedule. Rough grading of the filter strip should not be initiated until adequate erosion controls are in place.

Soil Preparation

Topsoil should be 8 inches thick, minimum. If grading is necessary, the topsoil should be removed and stockpiled. If the subsoil is either highly acidic or composed of heavy clays, ground dolomite limestone should be applied at an appropriate rate based on soil and slope conditions.

Subsoil should be tilled to a depth of at least 3 inches to adequately mix in soil additives and to permit bonding of the topsoil to the subsoil. If the existing topsoil is inadequate to support a densely vegetated filter strip, then suitable material should be imported. Proper specifications for imported topsoil should include the following:

1. *The USDA textural triangle classification.*

2. *Requirements for organic matter content (not less than 1.5% by weight), pH (6 to 7.5), and soluble salt (not greater than 500 parts per million).*

3. *Placement thickness and compaction. Topsoil should be uniformly distributed and compacted, and should have a minimum compacted depth of 6 to 8 inches.*

All seeding, fertilization, and mulching should be per the Virginia Erosion and Sediment Control Handbook (VESCH), 1992 edition, or as specified by a qualified agronomist.

Maintenance/Inspection Guidelines

Vegetated filter strips require regular maintenance. Field studies indicate that these BMPs usually have short life spans because of lack of maintenance, improper location, and poor vegetative cover.

The following maintenance and inspection guidelines are **NOT** all-inclusive. Specific facilities may require other measures not discussed here. It is the designer's responsibility to decide if additional measures are necessary.

Filter strips should be inspected regularly for gully erosion, density of vegetation, damage from foot or vehicular traffic, and evidence of concentrated flows circumventing the strip. The level spreader should also be inspected to verify that it is functioning as intended.

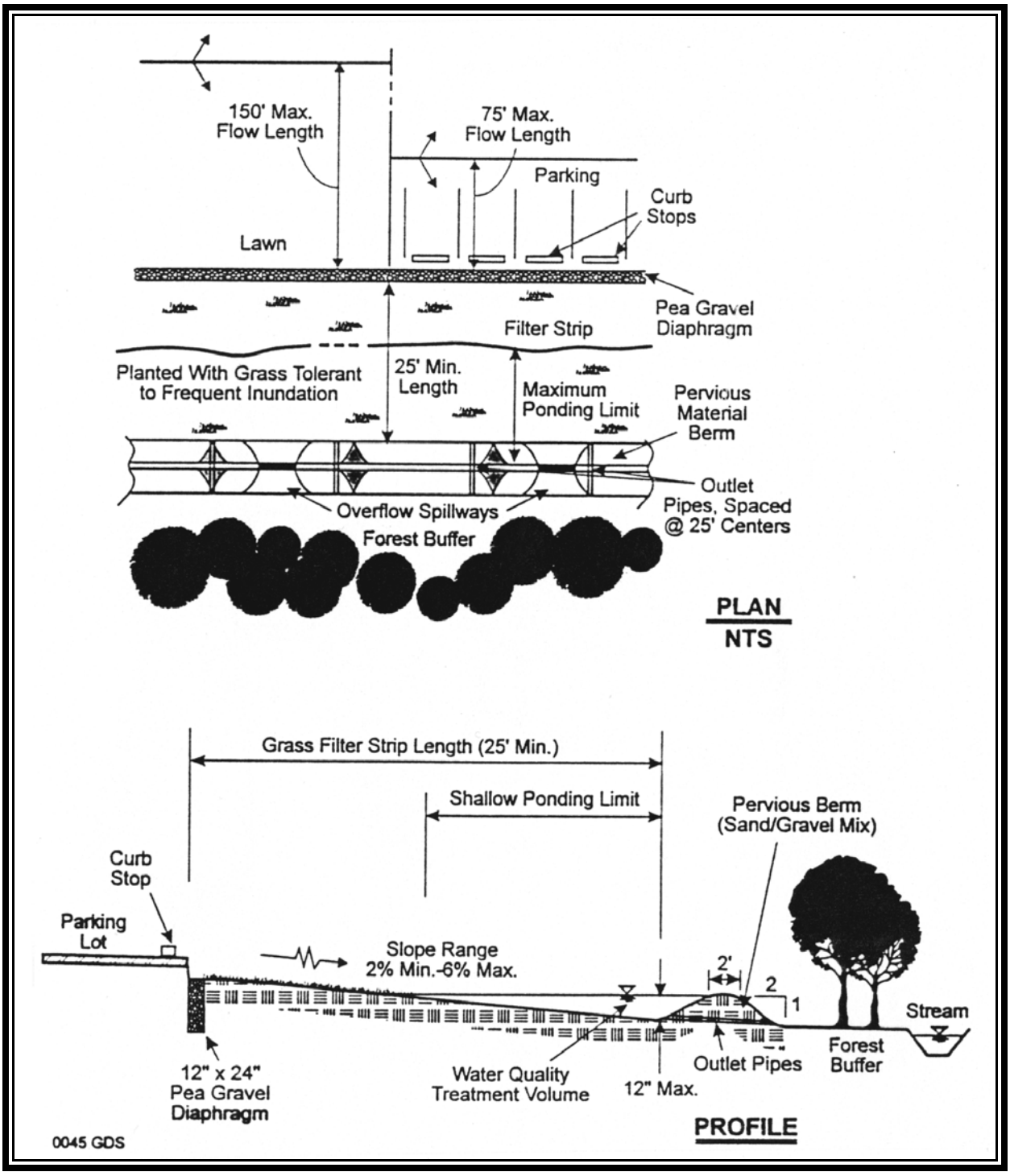
Inspections are critical during the first few years to ensure that the strip becomes adequately established. Maintenance is especially important during this time and should include watering, fertilizing, re-seeding or planting as needed.

Once a filter strip is well established and functioning properly, periodic maintenance, such as watering, fertilizing and spot repair, may still be necessary. However, fertilization efforts should be minimized. Natural selection allows certain species (usually native plants) to thrive while others decline. Excessive fertilization and watering to maintain individual plantings may prove costly, especially in abnormally dry or hot seasons. Overseeding and replanting should be limited to those species which have exhibited the ability to thrive.

To increase the functional longevity of a vegetated filter strip, the following practices are recommended:

- *Regular removal of accumulated sediment,*
- *periodic reestablishment of vegetation in eroded areas or areas covered by accumulated sediment,*
- *periodic weeding of invasive species or weeds, and*
- *periodic pruning of woody vegetation to stimulate growth.*

FIGURE 3.14 - 1
Vegetated Filter Strip



Source: Design of Stormwater Filtering Systems, Center for Watershed Protection,1996

FIGURE 3.14 - 2

Level Spreader

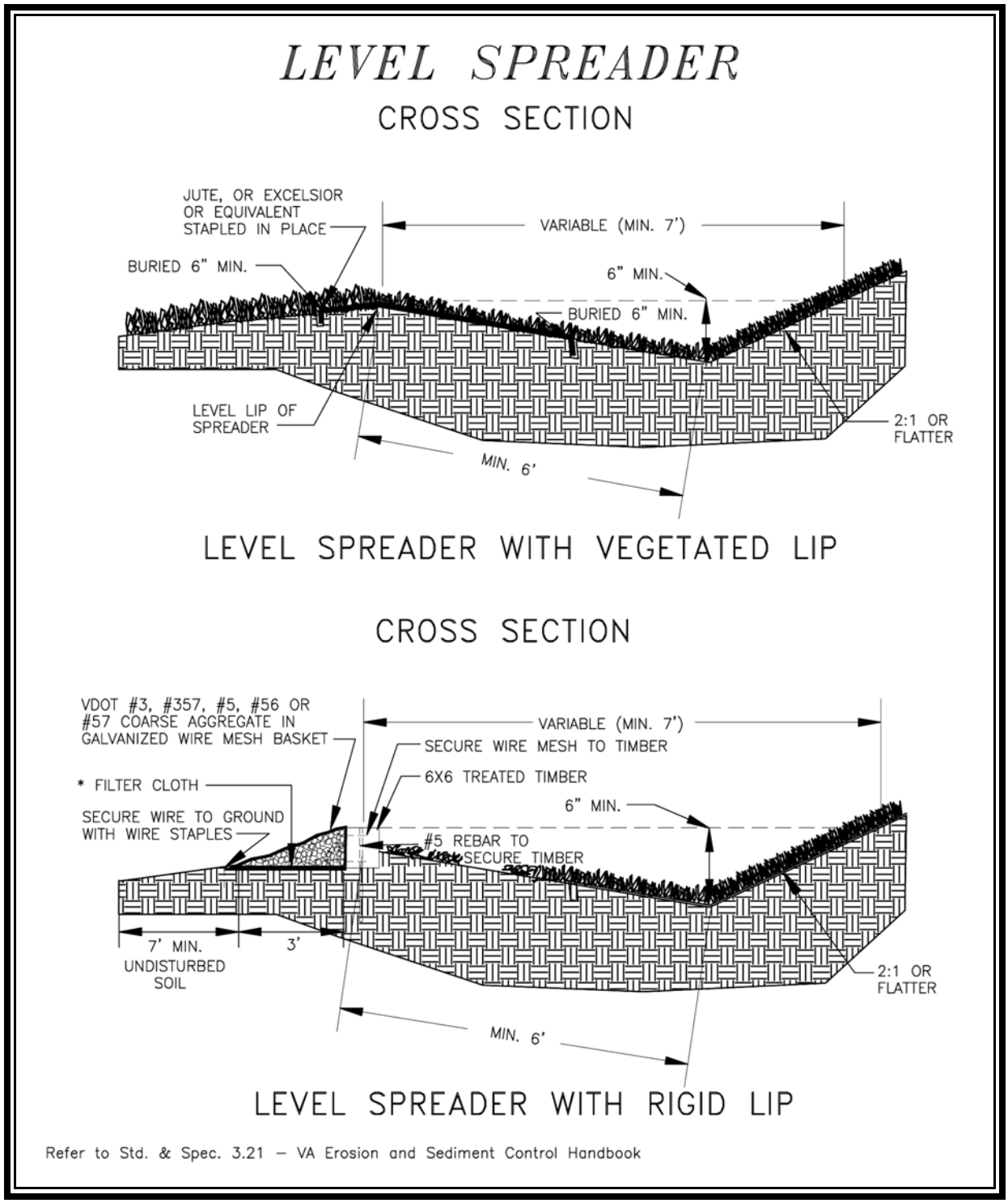


FIGURE 3.14 - 3
Virginia Physiographic Regions

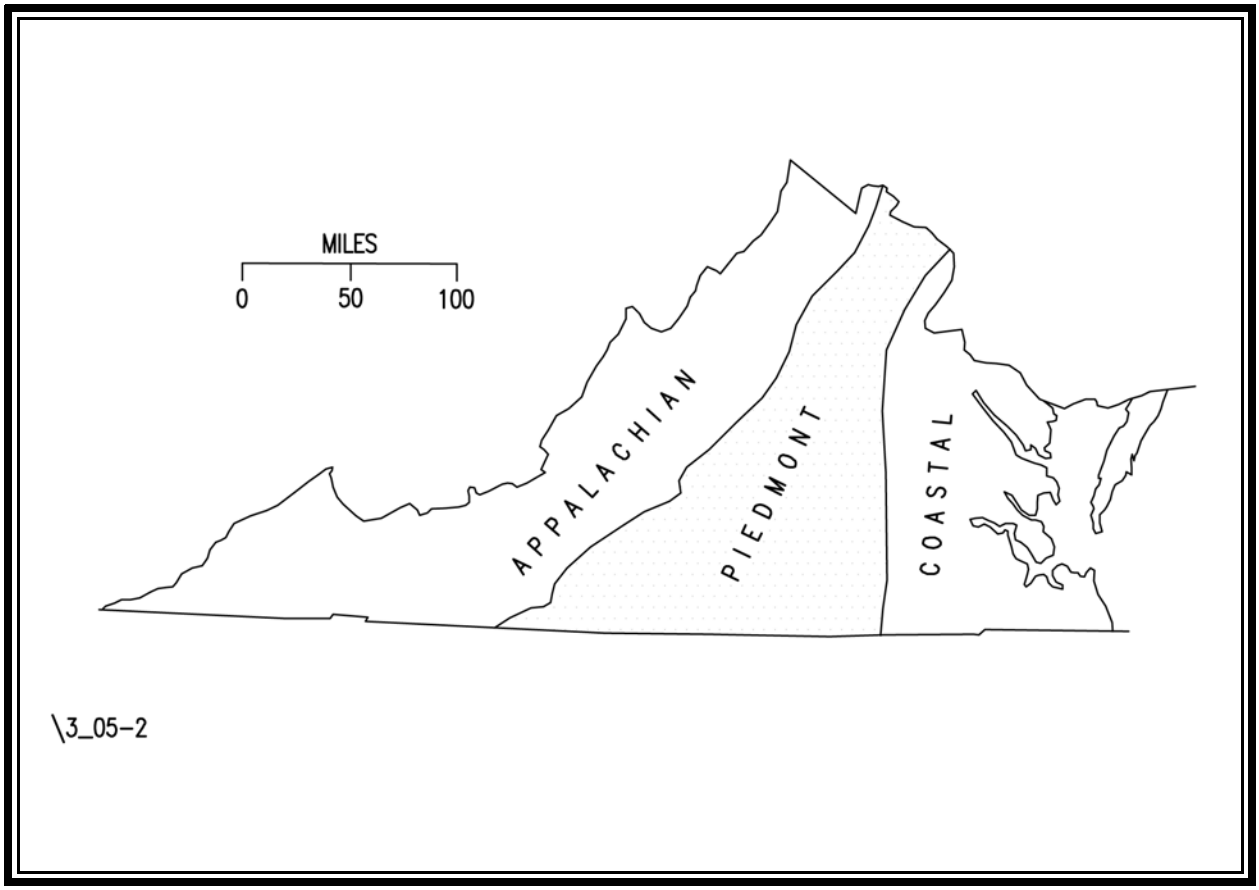
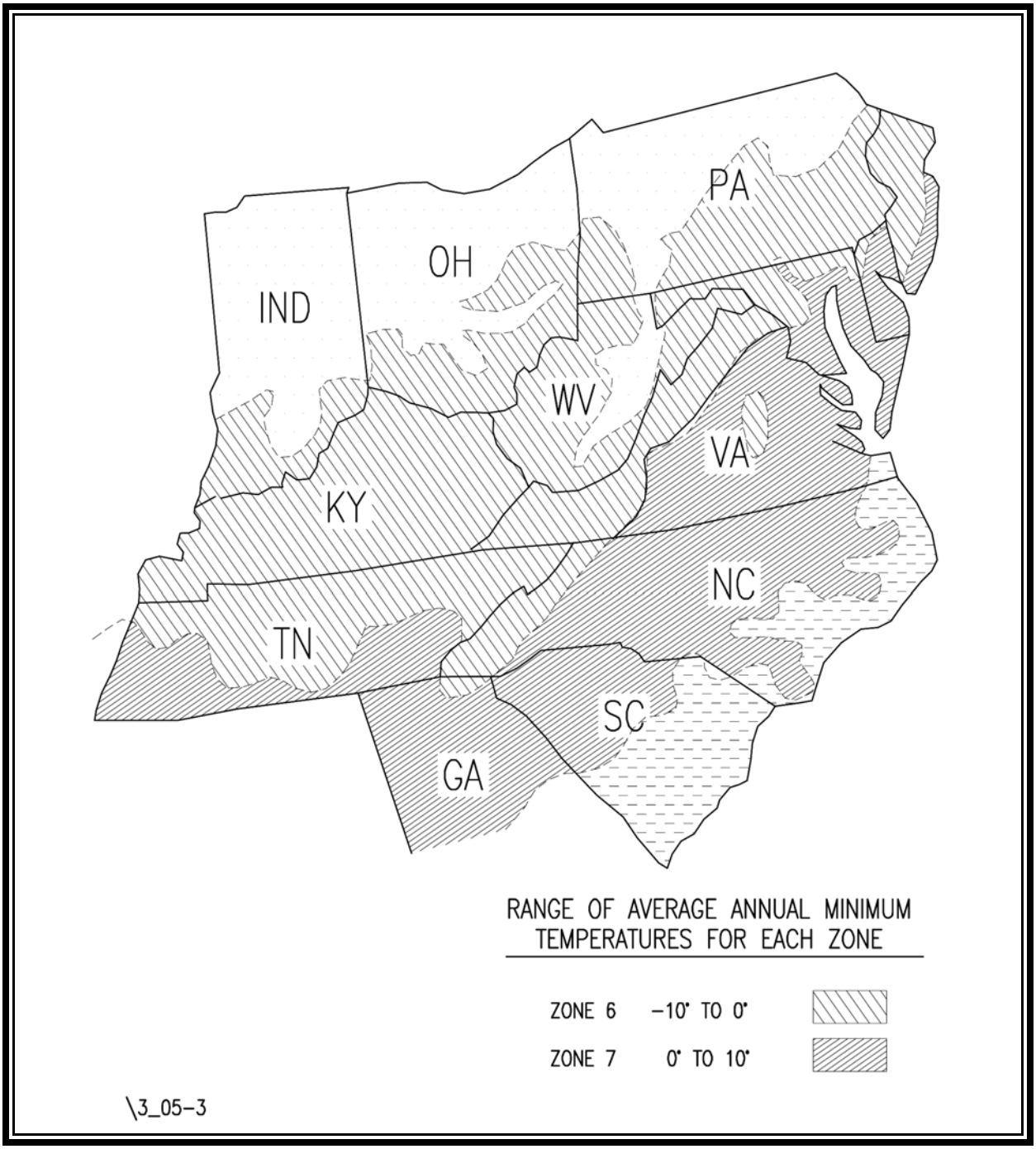


FIGURE 3.14 - 4
USDA Plant Hardiness Zones



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Vegetated Filter Strip. Note landscaped areas parallel to contours to force runoff to spread out. No evidence of channel flow short circuiting filter strip.

Vegetated Filter Strip